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Numerical solution of suggested fast fixture hanger

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Abstract

Fast and flexible line up of the tools to the mobile energy resource without the human help is possible with fast fixture hanger. Automatic or semi-automatic fast fixture hanger reduces the human and technical risk to the minimum and shortens the operating time of the connecting and disconnecting of the machine. For the assurance of the quality and safety of the using and unprofessional operating there was made a strength control of the designed frame of the fast fixture hanger. The stress analysis was accomplished by the finite element method by Cosmos/M program. According to inconvenient stress, which was uprising in the critical locations of the frame there were made some modifications. These modifications increased the frame toughness of fast fixture hanger.

Keywords: fast fixture hanger, stress, strength

Nomenclature

R_e	Limit of elasticity (MPa)
$F_{t\max}$	Maximal tension force (N)
F_{tl}	Force in the left rod (N)
F_{tp}	Force in the right rod (N)

1. Introduction

Economy development of any state necessary brings mechanization and automation not only in the industry, building industry, but also in the agriculture and other sectors. Effective and meaningful using of the resourses of the work mechanization and automation is very important. Carrying elements of machines and equipments in mechanical engineering, metallurgy and power industry are mostly during their operation under extremall loadings that decrease their lifetime. For the assessment of their safe operations is suitable to use analytical, numerical and experimental methods of mechanics [1].

Using of the mechanization, which is inseparable part of the production process, improves working conditions and eliminates the physical effort by the work. Work variety, mobile character and small cycle track of the work process poses specific claims to the construction of the agricultural machines. For the connection of the mobile energy means with the work machines or tool for practicing of the most different sorts of work, the mobile energy means have to have suitable

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connecting equipment. These equipments will allow to connect the work machine or tool and with its help practice the required sort of work in the work position and they will make possible to insure it in the transfer position at the same time. The connecting equipment is more perfect, the mobile energy means is more universal. Hanging equipment is used for special single-purpose machines and equipments, trailers and semi-trailers to the mobile means. According to the way of connection to the mobile energy means, the connecting equipment are divided into trailing (hanging), semi-trailing, semi-mounted, mounted [4].

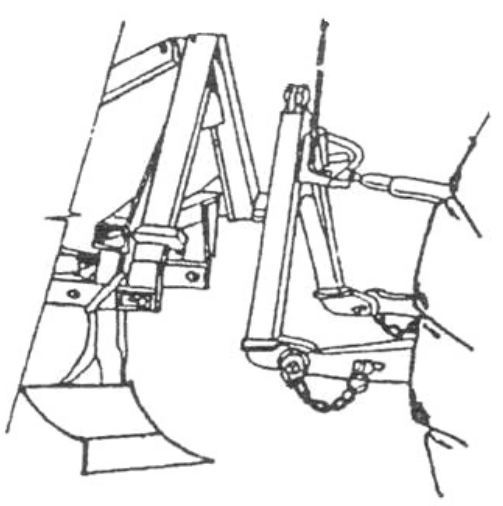

Fig. 1. The fast fixture hanger on the apparatus and tools

Trailing machines have own chassis, on which is the machine weight lying in the transport and work position. They are connected to the vehicle in one hanging point, during that time the tool weight does not weight down the self-propelling machine by the work and transport. They are connected in one, but often in two hanging points. Semi-trailing machines are connected by three points to the vehicle with three-point linkage. This way of connection makes possible to pick up the tools completely, so they are mounted in transport position. Mounted machines are connected to the vehicle by three-point linkage, so the whole weight of tools is carried on the back driving axle of the vehicle.

The fast fixture hanger is a mechanism, which makes possible the quick and easy connection of the mounted tools to the three-point linkage of the hydraulic means directly from the operation place of the tractor without a physical effort (Fig. 1). The hanger, by the one-phase system of connection, is made from two parts namely from the tool frame and hanger frame. The frame on the hydraulics has to be lower like the machine frame, by the uptake of the hydraulics the both frames will automatically join and fix together. The safety-catch will lock-off by the decoupling and with the hydraulics activation will the machine detach form the tools [3, 4].

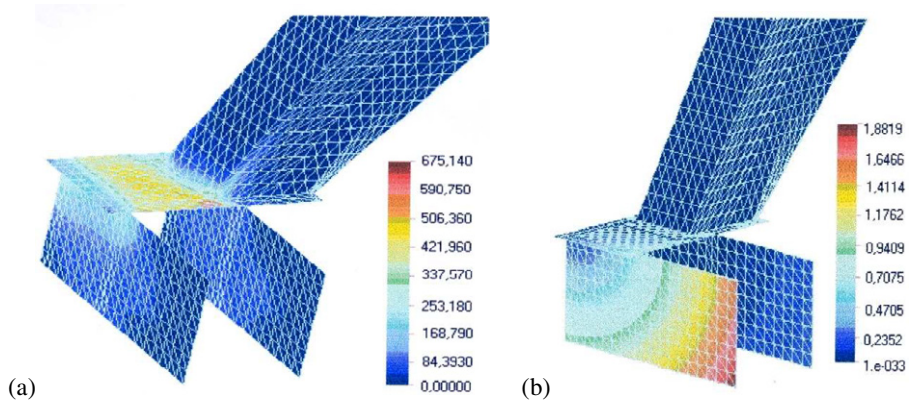

Fig. 2. (a) Field of equivalent stress frame and (b) Field of deformations of the fast fixture hanger.

For the strength calculation of the fast fixture hanger we used the finite element method, which is the most effective method of the solution of mechanics problems. The finite element method respects the geometry of the body, material properties, weight effects and border conditions. By the strength control we used the software product Cosmos/M. The fast fixture hanger was solved like a shell element and we used elements SHELL3. The element SHELL 3 is calculated for the construction solving of the thin-walled panels and shells. The basic shape of this element is triangle [2].

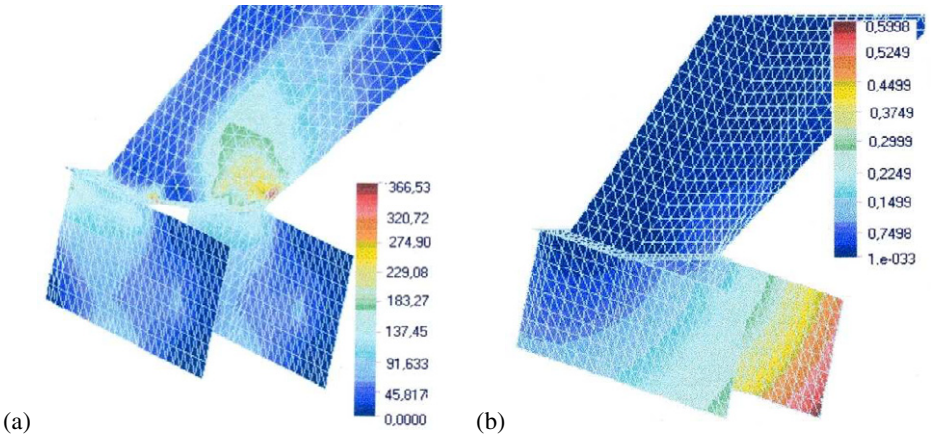

Fig. 3. (a) Equivalent stress after the first modification (b) Deformation after the first modification.

2. Stress analyses of the triangle fast fixture hanger which is fixed on the tool

Fast fixture hanger has a triangle shape, where the basic frame is connected to the three-point linkage and the auxiliary frame is attached to the tools. The basic frame is engaged into auxiliary one by the connection, where it is ensured by the safety catch. The triangle frame, which is connected to the hydraulic means of the three-point tool linkage with the rods, was designed from the pipes TR60x4, material 11523 and metal plate of thickness from 7 to 20 mm material 11484. These materials have a yield point $R_e = 340 - 365$ MPa . By the calculation we started from the loading caused by the hanging of the tools, which was the plough with the weight 1100 kg. The raising power for the plough with this weight is 22000 N. Maximal tension force in both rods is $F_{t\max} = 61752$ N .

The power in right and left rod is not the same and so the maximal tension force was devided for the left and right rod in the rate of: $F_{tl} = 0{,}4 \cdot F_{t\max}$, $F_{tp} = 0{,}6 \cdot F_{t\max}$.

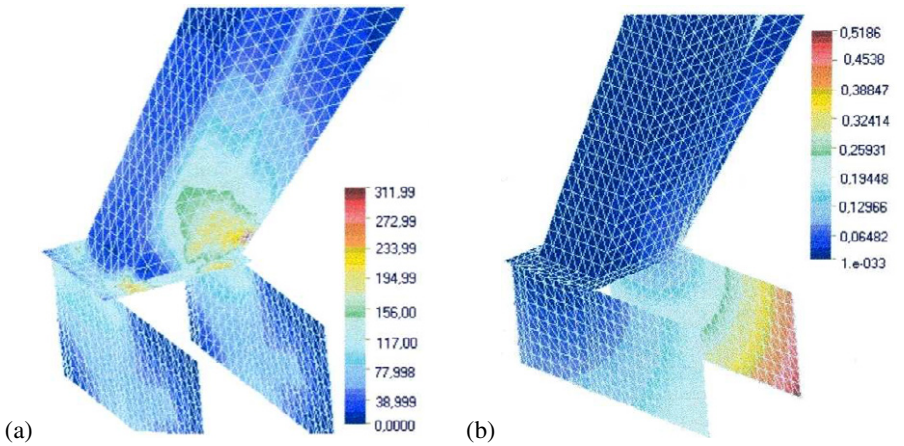

Fig. 4. (a) Equivalent stress in the frame after the second modification (b) The frame deformation after the second modification.

In consideration of the frame symmetry the half of the frame hanger was modeled. The frame was modeled in the program COSMOS/M according to the drawing pattern and meshed by elements SHELL3.

By the stress analyses there were found out high stresses in the area between the arms, where the whole frame is connected by the arms to the rods of the tools - the tractor (Fig. 2a). The biggest deformations were found out in the left arm, which is connected to the rod (Fig. 2b). The stress in these places is higher as the yield limit of the material. In consideration of the inconvenient stress we made modifications by the loading for the depression of the stress.

The first modification was the elimination of the ineligible surface that we slid the clamping of the frame pipes to this surface. We reached the stress decreasing to the half by this modification (Fig. 3). Seeing that also in this case the loading activated higher stress like it is possible for the material, by the second modification we changed the thickness of the connecting metal plate. We acceded to the second modification. This modification consists of the changing the thickness of the connecting metal plate from 20 mm to 25 mm. Maximal stress decreased to 311 MPa (Fig. 4a). The deformation of the arms decreased from 1,89 mm approximately to 0,52 mm (Fig. 4b) [2].

3. Conclusions

For the designed hanger, which was mounted on the tool, there was discovered high stress by the numerical solution with the finite element method in the program Cosmos/M, which was inconvenient for the yield point of the material. By the modification of the hanger construction we decreased the stress to the half, but it did not answer the strength conditions. For all that the second modification consists of the changing the metal plate thickness, where are mounted the frame arms and pipes of the hanger. By the way the stress in the construction decreased under the yield point so the construction answers the strength. The deformations in the fast fixture hanger have markedly decreased too by the modifications in the designed hanger [2].

Acknowledgements

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